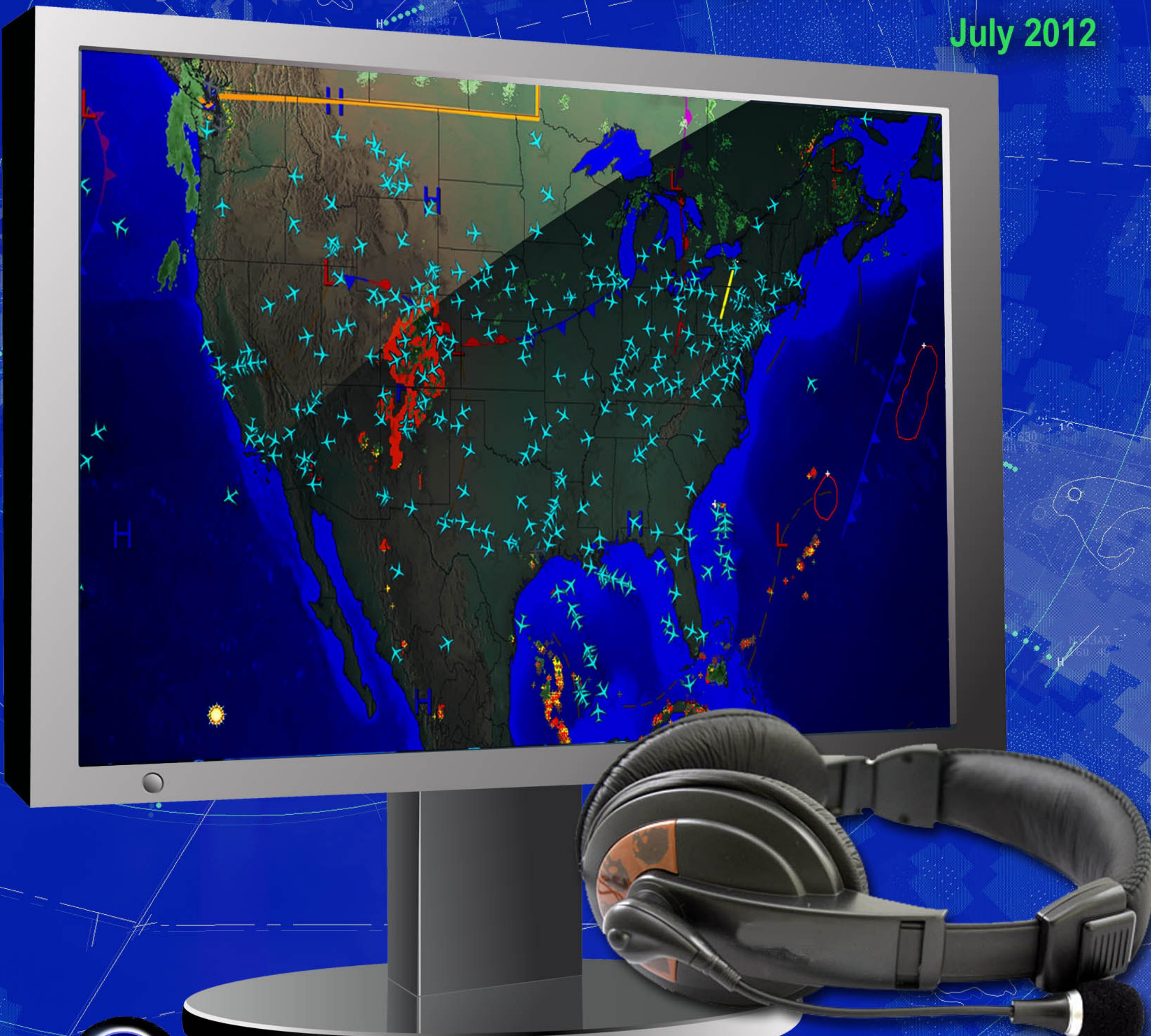
Joint Planning and Development Office

Flight Operations Centers: Transforming NextGen Air Traffic Management FOC Study Team Report

July 2012



Next Generation Air Transportation System
Joint Planning and Development Office

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JUL 2012**	2. REPORT TYPE	3. DATES COVERED **00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE **Flight Operations Centers: Transforming NextGen Air Traffic Management FOC Study Team Report**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Joint Planning and Development Office,1500 K Street, NW Suite 500,Washington,DC,20005**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**26**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

CONTENTS

Executive Summary

This report documents the findings and recommendations of the Airline Operations Centers (AOC)/Flight Operations Centers (FOC)/Wings Operations Centers (WOC) Study Team (herein referred to as FOC). The Study Team was commissioned by the Joint Planning and Development Office (JPDO) and supported by the NextGen Institute. The purpose of the report is to bring greater attention and focus to the important role that FOCs should play in the evolution of the Next Generation Air Transportation System (NextGen). The overall goal is to identify opportunities for making broader system improvements through expanded FOC-NextGen interaction. This expansion represents a new form of cooperative partnership that can accelerate implementation of NextGen capabilities, reduce program risk, and improve return on investment.

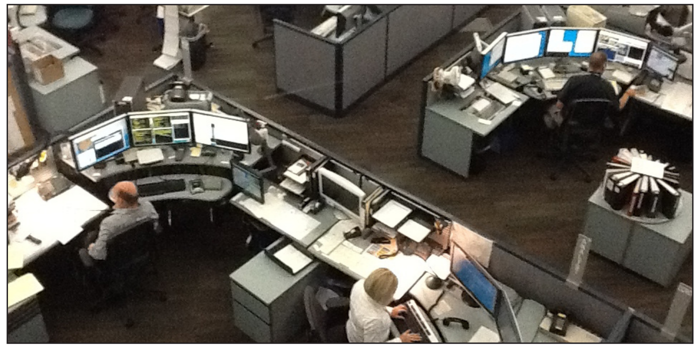
Several subject matter experts (SMEs) from industry and government, including personnel from major air carriers and regional airlines, the National Business Aviation Association (NBAA), Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Federal Aviation Administration (FAA), participated in a series of workshops driven by a core team led by industry and the FAA. During the 10-month process, participants explored the role of the FOC in the NextGen Implementation Plan (NGIP) and the JPDO's Joint Planning Environment (JPE). Areas where FOC involvement was found to be too minimal are summarized in the report findings. Additionally, opportunities for making a course correction in NextGen through greater FOC interaction are summarized in the report recommendations.

The report finds that while many of the stated NextGen capabilities and Operational Improvements are not possible without the FOC, the FOC's role is de-emphasized or omitted entirely from NextGen planning documents. Further, the report finds that lessons learned from ongoing efforts such as Collaborative Decision Making (CDM) are not incorporated into NextGen documents in the form of research areas or operational improvements. The findings were:

- **Finding 1:** The current NextGen approach is focused on Air Traffic Control (ATC) modernization rather than National Airspace System (NAS) transformation. This is evident in NextGen's individual flight- and pilot-controller emphasis, and the lack of a system focus. Specifically, Trajectory-based Operations (TBO), the key operating paradigm of NextGen, lacks full consideration of FOC decision processes. The FOC's role is key to initiating trajectories. The FOC should also play an important role in the Air Traffic Management (ATM) process throughout the lifecycle of the flight.
- **Finding 2:** Today's FAA planning horizon is not sufficiently strategic and lacks continuity across the decision-making process. As reflected in NextGen planning documents, NextGen does not improve upon this current limitation.
- **Finding 3:** There is no clarity on how scarce NAS resources will be rationed in the NextGen environment. The strengths and weaknesses of today's methods of resource rationing have been documented through the CDM processes, yet the vital need to repair these weaknesses is not addressed in NextGen planning documents. In NextGen, it remains unclear what the right rationing mechanisms are when NAS resources (e.g., airport and airspace capacity) become constrained, or how NextGen prioritizes flights.
- **Finding 4:** The rules and content for data sharing are not clearly defined. While NextGen stresses the importance of "distributed decision making," increased user focus, and provisioning information to users, the current NGIP does not address the data availability, rules, and related processes that will be required to bring this to fruition.
- **Finding 5:** There is a lack of appreciation for and incorporation of the role of the FOC to ensure the success of the FAA Data Communications (Data Comm) program.

The report recommends expanded FOC involvement in NextGen planning and development processes as a means of achieving broader system benefits and ensuring a proper focus is placed on transforming the air transportation system. The report's recommendations span the entire NextGen program lifecycle from concept initiation to implementation.

- **Recommendation 1:** Involve the FOCs upfront and continually in NextGen planning and implementation activities. This should include direct participation in concept exploration, development, and verification and validation processes, as well as operational trials and demonstrations. Specifically, FOC decision processes need to be directly integrated into TBO planning documents and related tests and experiments.
- **Recommendation 2:** Expand the present FAA planning horizon to improve strategic decision making. This should be implemented progressively. The associated data sharing and procedural changes needed to implement the expanded planning horizon should also be developed.
- **Recommendation 3:** Determine and implement clear and improved rationing mechanisms for NAS resources that become scarce. NextGen should leverage lessons learned from CDM and ensure that rationing mechanisms provide proper incentives for demand reduction, address equity issues, and provide operators with fleet and system optimization-enabling mechanisms.



- **Recommendation 4:** Expand and formalize data sharing. Uniform rules for data sharing should be developed that address roles, responsibilities, quality, timing, and governance. Formalizing rules for protecting proprietary data, accessing System Wide Information Management (SWIM), and standardizing all data-sharing activities are related activities that are also needed.
- **Recommendation 5:** Broaden the perspective on Data Communications. NextGen Data Communications should be expanded beyond pilot/controller interaction by leveraging the experience, capabilities, and infrastructure of FOCs. The FAA Data Communications Program Office should reach out to the FOC community and create an FOC/ATC data link communications working group as a means to this end. The FOCs should also be involved directly in developing the processes and procedures to handle data link messages between controllers and the flight deck.
- **Recommendation 6:** Conduct collaborative experiments with FOCs. Important NextGen experiments and trials (e.g., Greener Skies, NextGen Test Bed, JetBlue Other Transaction Agreement [OTA]) should continue but with greater FOC involvement. Additional NextGen experiments should be constructed and conducted with specific FOC focus. Some suggested experiments with this focus include:
    - Improving data-sharing processes and data
    - Developing enabling capabilities for an expanded, planning time horizon
    - Exploring the concept of an improved "unifying" approach to resource rationing
    - Developing and implementing collaborative system metrics
    - Concept exploration and development of the role of the FOC in trajectory negotiation in a TBO environment

The Study Team concluded that greater FOC involvement will ensure that NextGen development produces results that are markedly better for the broader transportation system. However, failure to recognize the evolving importance of the FOC will limit NextGen to tactical, individual flight-focused, sub-optimal operations.

Background

On June 22, 2011, the Joint Planning and Development Office (JPDO) held a meeting to discuss the involvement of Airline Operations Centers (AOCs), Flight Operations Centers (FOCs), and Wing Operations Centers (WOCs)[1] in the Next Generation Air Transportation System (NextGen) planning process. Through the NextGen Institute, several members from industry were invited, including personnel from the major air carriers, the regional airlines, and the National Business Aviation Association (NBAA). Personnel from the Department of Defense (DOD) and National Aeronautics and Space Administration (NASA) were also invited. The issue at hand was that the Federal Aviation Administration's (FAA) NextGen Implementation Plan (NGIP) (the 2011 edition)[2] and the JPDO's Joint Planning Environment (JPE)[3] made only notional mention of an FOC in the NextGen environment. The assumption was that technology would exist for the flight planning and dispatching in a negotiated Four-Dimensional (4D) Trajectory-based Operations (TBO) environment. While that may be a safe assumption, there is a risk of missing opportunities for making broader system improvements by limiting NextGen/FOC interaction to the world of flight planning and dispatching individual flights. Flight planning is just one of an FOC's functions in three major categories of responsibility:

- Flight management – meeting the federal regulatory and safety requirements of each flight
- Schedule management – balancing operating resources (aircraft, crew, equipment, and facilities) to support schedule changes
- Network management – optimizing operational performance and managing recoveries from major service disruptions (e.g., severe weather, security, etc.)

This gap in NextGen planning was recognized as an opportunity for a course correction. Therefore, it was determined that a Study Team should be initiated to bring focus and attention to the important issues that need to be addressed by the FOC in the evolution to NextGen.

The FOC Study Team has met several times over the past year and conducted three workshops that included subject matter experts (SMEs) from government and industry. This report documents the findings and recommendations of the FOC Study Team.

---

[1] **Throughout the rest of this report, FOC will be used to signify AOC/FOC/WOC inclusive.**

[2] **FAA NextGen Implementation Plan, March 2011.**

[3] **JPE Joint Planning Environment: http://jpe.jpdo.gov**

Introduction

The FOC is a key element in a successful Safety Management System (SMS). Elements of an SMS include deicing, maintenance planning, dispatcher and pilot training, regulatory requirements, etc. The FOC exercises centralized control of all operator assets necessary for safe and efficient flight operations, including the important function of flight planning for scheduled and unscheduled flights.

Historically, FOCs have implemented stand-alone decision-support capabilities that operate independently of FAA technologies. The TBO electronic negotiation process implies a much tighter coupling between FOCs and FAA systems. This requires investments by both the operators and the FAA in systems and the collaborative process. In the NextGen pilot/controller-centric paradigm, the notion of a public/private partnership revolves around government-backed investment and/or loan guarantees for aircraft avionics. The FOCs are presently investing in flight planning and other technologies that are required for NextGen. The Study Team envisions a new type of cooperative partnership that leverages these and future investments by the FOCs. This represents an expanded view of a collaboration and joint commitment in the form of cooperative partnership that will accelerate the benefits of NextGen.

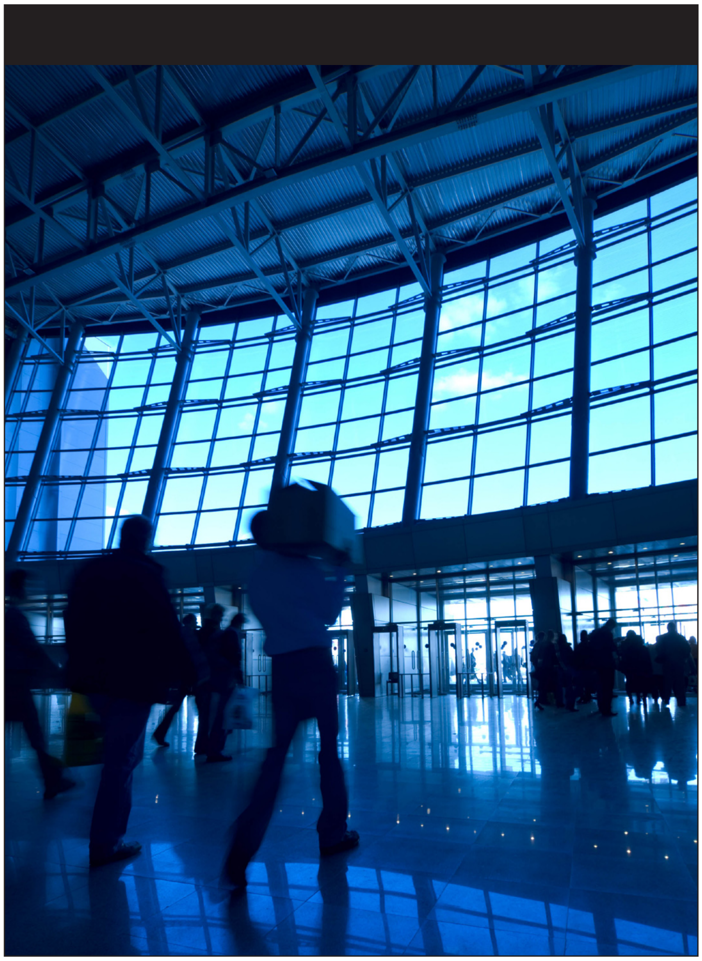
FOCs have been instrumental in landmark changes to Air Traffic Management (ATM), such as the Collaborative Decision Making (CDM) effort, which evolved from the identified need for a shared understanding of ATM problems. CDM has been an FAA/industry business philosophy for quite some time. Based on information exchange, shared situational awareness, and distributive decision making to the most appropriate point, decisions affecting the safety and efficiency of the National Airspace System (NAS) are determined collaboratively by all involved parties. This cooperative effort between the various components of aviation transportation, both government and industry, allows for the exchange of information, clarification of roles and responsibilities, and codification of those roles in rules of engagement, therefore fostering better decision making. Enhancing the information exchanged to include other components of the air transportation system will produce more efficient results for the broader transportation system, which will be needed with the increase in demand anticipated over the next decade.

Data sharing is a prerequisite to common situational awareness and collaboration among NAS stakeholders. It is needed for efficient operation of the NAS and mutual attainment of individual and collective stakeholder objectives. Successful implementation of NextGen requires a clear understanding of data-sharing requirements. This is essential to effectively create, execute, and efficiently adjust planned operations as conditions change. An ideal outcome would be for maximum system performance,

while enabling the operators to optimize their business objectives subject to changing NAS constraints.

Important data-sharing lessons were learned from the development of CDM. These lessons are relevant and transferable to the future, particularly to preserve the gains achieved over the past two decades and generate even more gains under NextGen.

- If there is any penalty, real or perceived, then organizations will not share data. With CDM, ration-by-schedule was developed to eliminate the double penalty associated with sending in dynamic schedule information.
- Incentives may be necessary for operators to send in required data. With CDM, compression was developed to provide a positive, measureable incentive, which was essential to participating airlines in justifying the investment costs needed to develop their information exchange mechanisms.
- New rules of engagement are often required. With CDM, the movement to unlimited slot swapping was a central part of the initial CDM deployment. This change enabled operators to mitigate the impacts of ground delay programs on their networks (i.e., schedules). It is a key example of how data sharing alone is often insufficient; the rules of engagement and associated processes and procedures (and tools) must often also be changed in a collaborative data-sharing environment to attain the desired outcomes. It is highly unlikely that the airlines would have participated in the data exchange without the movement to unlimited slot swapping.
- Data sharing alone does not eliminate problems associated with poor predictions or poor data quality. With CDM, while there has been significant improvement in the quality of demand data, problems have persisted with bad event time predictions. Often, this is because some operators are not sending in quality, up-to-date information. At other times it is because the data they are sending is a prediction, and events outside of their control can produce outcomes different than what they predict (e.g., unexpected mechanical delay, or lengthy departure queues, or not receiving a departure clearance due to a convective weather event).



In the NextGen environment, the need for data sharing will be greater, as will the opportunities to leverage data for the individual and collective good. Clarity on how the data will be used and the causal relationships between the use of data and resulting improvements is paramount. The quality and timeliness of data, not just the quantity, have a significant bearing on how well systems, subsystems, and decisions work. There is room for much improvement under NextGen.

As NextGen continues to be developed, it is vital to preserve the gains that have been made and identify opportunities to produce additional improvements. While the specific technologies may require replacement, the underlying principles of rewarding desired behaviors and allowing each stakeholder to do what it does best should be preserved. Aircraft operators need to gain a better understanding and appreciation of what the FAA is seeking to accomplish in order to better support the FAA in improving the operation of the NAS. Similarly, the FAA needs to gain a better understanding and appreciation of what aircraft operators are striving to achieve to better support them in attaining their business or mission objectives. Aircraft operators in many instances are striving to efficiently and profitably satisfy demand for services. Toward this end, they must adjust flight schedules; schedule aircraft and crews with a multitude of constraints; ensure that gates and ground personnel, equipment, and services are scheduled; and they must make significant changes to deal with disruptions and minimize negative impacts to their operation and the customers they serve–particularly during periods of disruption. They are struggling to preserve the integrity of their supply chains. The FAA and aircraft operators need a better understanding and appreciation of the other's operation and objectives, so they can each be more mutually supportive of the other.

Why FOC Involvement is Essential in NextGen Planning

Involving FOCs in NextGen planning and evolution is essential to accomplishing the planned NextGen operational improvements and capabilities. NextGen capabilities stress the importance of “distributed decision making… increased user focus and the provisioning of information to users.”[4] Net-centric Operations facilitate shared situational awareness through comprehensive information exchange to inform the CDM process. NextGen capabilities for collaborative capacity management, collaborative flow contingency management, flexible airport facility and ramp operations management, air transportation security, and efficient trajectory management all require a robust, scalable, and flexible data-sharing framework between air navigation service providers (ANSP), in this case the FAA and FOCs. This allows the dynamic and integrated management of air traffic and airspace that meets the operational objectives of NAS users and provides access, efficiency, and predictability for flight operators and system stakeholders.

As established in the JPDO’s NextGen Integrated Work Plan (IWP), the FAA, in collaboration with system users, continuously evaluates the flight day to develop mitigation strategies for real-time and potential system constraints to maximize available capacity and airport throughput and increase operational predictability of the system (OI-0305 Continuous Flight Day Evaluation). The FOC has to be an integral part of accomplishing this operational improvement (OI), which requires that operational data be shared for improved and predictable flight planning. More efficient sequencing of arrivals and departures, as well as improved management of surface operations (OI-0320 Initial Surface Traffic Management, OI-0331 Improved Management of Arrival/Surface/Departure Flow Operations) is also achieved through increased information flow that supports CDM. Flight operators and the FAA can then effectively manage high-capacity arrival and departure flows, as well as allow operators to more efficiently plan and manage operations that meet their business objectives. Full CDM, OI-0385, is achieved through timely, effective, and informed decision making based on shared situational awareness through information-sharing systems. This should lead to a greater understanding of NAS constraints and how they translate into flight impacts, as well as clarity on the options that enable them to optimize their operation subject to the constraints. Accomplishing these objectives is not possible without the essential involvement of the FOC.

[4] Operational Concept for the Next Generation Air Transportation System (NextGen)

Team Process and Workshops

The FOC Study Team was co-led by one government representative and one industry representative, and consisted of a core group of government and industry members. Workshop participants included government and industry SMEs. The emphasis of team was to understand current operations, the opportunities, and challenges specific to FOCs, and how they might emerge in the evolution and transition to NextGen. The outcome of this activity will serve as a key component in part of the overall effort to define the concepts for integrating and evolving the FOCs to the desired end-state functionality.

The following workshops were conducted:

- Workshop One – November 30 – December 1, 2011 – Role of FOCs in the Evolution of NextGen
- Workshop Two – February 22-23, 2012 – Data Exchange and Sharing
- Workshop Three – May 15-16, 2012 – Role of the FOC in the Transition from an Air Traffic Control Model to an Air Traffic Management Model

More information on workshop participants is provided in Appendix A.

Participants at the May 2012 FOC Study Team Workshop.

Findings

Finding 1 – The current NextGen approach is focused on Air Traffic Control (ATC) modernization rather than NAS transformation.

The initial stated intent of NextGen was to transform the air transportation system. This differs from previous ATC modernization efforts (e.g., Advanced Automation System [AAS], Free Flight, etc.) that focused exclusively on the ATC component of air transportation and required little interaction with FOCs. An air transportation system is about moving people and goods, and hence has a much broader scope than ATC. FOCs play a major role in managing the complex interactions required for moving people and goods through the system, and need to be more actively engaged in NextGen for it to become more NAS transformative. While NextGen documentation (e.g., NGIP, TBO Study Team Report) still has a heavy pilot-controller focus, there has been a continued shift in the influence of the FOC in the operator community. This is in part driven by rising fuel prices. Dispatchers, for example, are loading less and less extra fuel beyond what is required to safely conduct the flight, in order to keep fuel costs per flight at a minimum. This translates into very little latitude on the part of the pilot to deviate from the flight plan and suggests that effective planning and predictability have become more important.

Additionally, through advances in information technology, FOCs are able to exercise far greater centralized control of their assets—with de-centralized execution. This centralized control function has become essential to the movement of passengers and goods through the system, safely and efficiently. NextGen is not recognizing these FOC evolutionary developments, as evidenced by the greater emphasis that is being placed on pilot-controller interaction than traffic manager-FOC interaction.

NextGen presently has an individual flight and pilot-controller focus.

NextGen places significant emphasis on pilot-controller interaction associated with individual flights, the ATC component of air transportation. This is reflected in NextGen plans (e.g., FAA NGIP), operational concepts, research and development efforts, and operational trials. Further, pilot-dispatcher joint responsibility, required by the Federal Aviation Regulations (FARs), is minimized in NextGen documents. There has been little emphasis placed on the decision-making processes of the FOCs and their critically important role in the optimization of the air transportation system. As opposed to flight-specific decisions, the FOC continually assesses the impact on the entire network of their flights to determine optimum accomplishment of their business objectives. If this lack of emphasis on FOC decision making continues, there is a substantial risk that NextGen will evolve solely as an ATC modernization effort. A major omission in NextGen planning documents is a basic analysis of–given a particular situation–who should be the principal decision maker and why. The prevalent assumption is that every situation converges immediately to pilot-controller interaction. It may be that with proper FOC-traffic management interaction many situations (e.g., airspace congestion) could be avoided, obviating the need for controller intervention. The lack of formal and informal means for cross-training dispatchers and controllers may contribute to an inadequate understanding of the roles and responsibilities of each of the parties.

NextGen presently lacks a system focus and therefore may not deliver expected system benefits.

The FAA cannot optimize the air transportation system by making a collection of flight- specific pilot-controller decisions. It lacks insight into the drivers of operating costs, the network connections that move people and goods, or the many issues (e.g., crew schedule, gate availability, revenue, passenger connections) that make one flight more time-critical than another. Only through connecting with the FOC decision-making processes, which have prime responsibility for driving fuel policies, making fleet decisions, and assessing the expected and actual economic benefits of NextGen, can we ensure NextGen will improve the transportation system, properly emphasizing strategic and fleet decision making, and not just improving the ATC component. As has been pointed out in a recent study[5], a reduction in flight delay does not necessarily translate into a reduction in passenger delay. This is a consequence of network effects (i.e., an operator's time-space network of flights that is synchronized with the published schedule, aircraft, and labor availability) and suggests that a much tighter coupling with FOCs is required to ensure NextGen helps improve the broader air transportation system.

TBO, the key operating paradigm of NextGen, currently lacks full integration of FOC decision-making processes.

The Executive Summary of the JPDO TBO Study Team Report[6] states that the objective of the report is to describe TBO for flight planning, surface movement, climb, cruise, and arrival using four-dimensional trajectory (4DT) management in the NextGen end-state. This should lead to broader implementation and use of TBO as a central element of NextGen. The report further describes a conformance-monitoring function both in the cockpit and with the FAA. Conformance to a negotiated and agreed-upon trajectory forms a contract between the operator/user and the FAA. However, the JPDO TBO Study Team Report

[5] L. Sherry, Director, Center for Air Transportation Systems Research, George Mason University. "Modeling Passenger Trip Reliability: Why NextGen May Not Improve Passenger Delays". The Journal of Air Traffic Control, Summer 2011.

[6] JPDO Trajectory-based Operations (TBO) Operational Scenarios for 2025.

also implies that this function is primarily a pilot-controller function. The FOCs, as the primary providers of trajectory-based flight plans, should be the principal point of negotiation with the FAA. This critical omission needs to be addressed.

Another example can be found in the Off-nominal Scenario discussed in the JPDO TBO Study Team Report. In this scenario, the importance of improved weather predictions is emphasized, and a TBO evaluation service is described in which weather and non-weather predictions are ingested to routinely determine the operational impact on requested trajectories. The JPDO TBO Study Team Report almost reflexively begins with pilot-controller interaction. Even in that area—off-nominal conditions—where networks are likely to suffer the greatest impact, FOC decision making is of paramount importance.

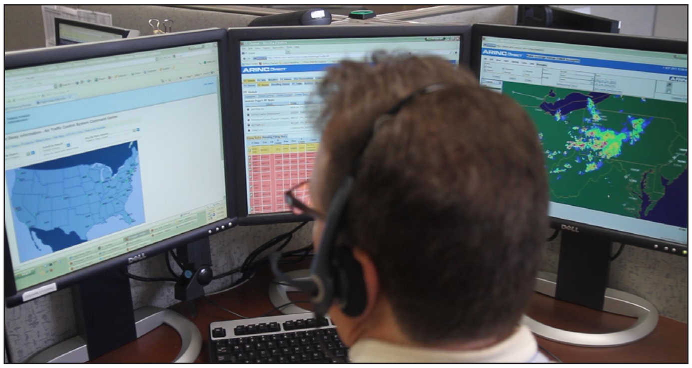
In NextGen, the FOC is not adequately considered in the ATM process throughout the lifecycle of the flight.

The JPDO TBO Study Team Report states, "It is important to emphasize that TBO is about choices. Once received, choices are negotiated, accepted, and then executed with precision. As the airspace traffic density increases, there is greater need for precision performance. However, TBO can function at any level of precision. It is the execution of the agreement that assures separation. Strategically, automation must provide choices to the operator/user that resolve downstream conflicts and address flows."[7] In an end state where the FOC is the central communication point for trajectory data, it will not be solely about choices, as stated in the report; it will also be about submitting the optimum trajectory based on the information on the status of the NAS that has been received and incorporated in the trajectory calculation. This need for a fully robust, near-real-time, common trajectory planning database of present and future NAS states, including the entirety of all NAS constraints and the expected flight impacts of those constraints, is essential to creating a fully collaborative constraint environment. As the status of the NAS changes and the information is communicated, the systems in the FOC will redefine the optimum trajectory and negotiate with the FAA up to a time when control will be conceded to the FAA for tactical management of airport arrival operations.

For example, consider a special use airspace (SUA) scenario. The SUA opens up after the aircraft has departed. If the negotiation began at the pilot-controller level, then several inefficiencies could ensue. The aircraft could arrive at the destination above maximum landing weight, requiring the aircraft to either burn fuel through holding, or dump fuel. Alternatively, the aircraft may be able to land, but there may be no gate available. Conversely, had the negotiation occurred immediately with the FOC, the FOC could recalculate the flight trajectory, assess any issue associated with ground resources, and determine an optimal trajectory based upon the newly opened SUA. In some cases, that may mean staying on the presently filed flight plan. The FOC would also assess any impacts associated with passenger and other network connections.

Finding 2 – Today's FAA planning horizon is not sufficiently strategic and lacks continuity across the decision-making process.

FOCs begin their planning processes long before the day of operation. Problems that are encountered early can be resolved with far less cost and less disruption than on the day of operation. NextGen could leverage these extended time horizons to produce more efficient methods of resolving congestion and other issues. One example in today's NAS is airport competitive scheduling, which can result in delays, excess fuel burn, and other inefficiencies. Another example is with special events, such as major sporting events, or the recent "last flight of the space shuttle." Creating joint awareness of NAS constraints and demands in an expanded time horizon can help resolve such constraint/congestion issues early, leading to improved planning, greater predictability, and less ATC intervention. This would lead to less delay, less schedule disruption, fewer crew legality issues, reduced gate availability problems, fewer diversions, and the avoidance of other high-cost consequences.



[7] Ibid.

Finding 3 – There is no clarity on how scarce resources will be rationed in the NextGen environment.

Rationing of airport and airspace resources becomes necessary when the capacity of those resources cannot meet the demand. While optimistic that NextGen will greatly enhance the capacity, one should not assume capacity-constrained conditions would cease to exist. The demand itself may grow, for example, outpacing the growth of capacity. Alternatively, there could be a movement to smaller, more fuel efficient aircraft (i.e., many more aircraft carrying the same number of people/goods). Or, there may be capacity loss on a given operational day due to weather, system outages, or other factors. In any case, the rationing mechanisms of the future should be transformative and lead to a marked improvement over today's rationing mechanisms and processes. Unfortunately, NextGen overlooks the importance of rationing, seemingly relying on a questionable assumption: in the future, capacity will be virtually unlimited and resources will not require rationing. The notion of rationing would seem especially important with the advent of other vehicle types that can be expected to compete for NAS resources (e.g., Unmanned Aircraft Systems [UAS] and commercial space). The alternative conclusion is that the important groundwork of CDM regarding rationing mechanisms will be lost, and NextGen will represent a step backwards when airport and airspace resources do become constrained.

It is unclear what the right rationing mechanisms are when NAS resources become constrained.

There are various characteristics of effective rationing, as learned through many years via the CDM program. Among the most important to operators are predictability, equity, and flexibility. Predictability enables operators to plan and effectively align their resources to mitigate the impacts on people and goods, minimize operating costs, reduce fuel burn, and attend to other aspects of system optimization. Equity ensures that there is relative fairness in the assignment of delays, re-routes, or other consequences of rationing. Flexibility refers to the ability of an operator to trade resources between flights or even with other operators to produce better fleet and system outcomes. None of these aspects of rationing are clarified in current NextGen plans.

These are some scenarios and observations from today's system that warrant improvement under NextGen:

Wasted Capacity: One of the worst outcomes for a major Traffic Management Initiative (TMI), such as a Ground Delay Program (GDP), is underutilized capacity. This has been a persistent problem for several years and can be caused by many factors. Examples include inaccurate demand information, poor weather predictions, conflicting TMIs (e.g., GDP impacted flights delayed by a Mile-in-Trail [MIT] and missing their arrival slot), or excessive queuing on the surface.

Inequitable Outcomes: The delays associated with a given TMI can be inequitably allocated, and this inequity can occur day after day. There is no scientific process for measuring equity, and there is no memory built into TMIs for ensuring that an inequitable outcome is accommodated in some future TMI.

Independent TMIs: There is presently no logic to ensure that multiple TMIs are de-conflicted, a process that would ensure that one TMI does not negate the intent/goal of another. Hence, the NAS is not truly managed as a system. This makes planning and network optimization extremely difficult, if not impossible, for the operators. For example, there are recorded instances where a single flight is impacted by as many as five or six different TMIs. Under NextGen, with the confluence of more accurate surveillance (ADS-B), more rapid communication (Data Comm), more precise navigation (Performance-Based Navigation [PBN]) and more comprehensive data distribution (System-wide Information Management [SWIM]), it should be possible to address all of the weaknesses associated with today's rationing mechanisms.

It is unclear how the system prioritizes flights in NextGen.

NextGen documents and concept papers do not address the topic of how flights are prioritized when resources have to be rationed, yet some type of flight prioritization is required when airport and airspace resources become constrained and not every flight can receive its ideal or optimum plan. For example, if airspace can only accommodate half of the planned/scheduled traffic due to convective weather, which half will get to use that resource as planned? The lack of a robust treatment of rationing and flight prioritization remains a glaring omission in NextGen planning documents and concepts of operations.

Finding 4 – The rules and content for data sharing are not completely defined.

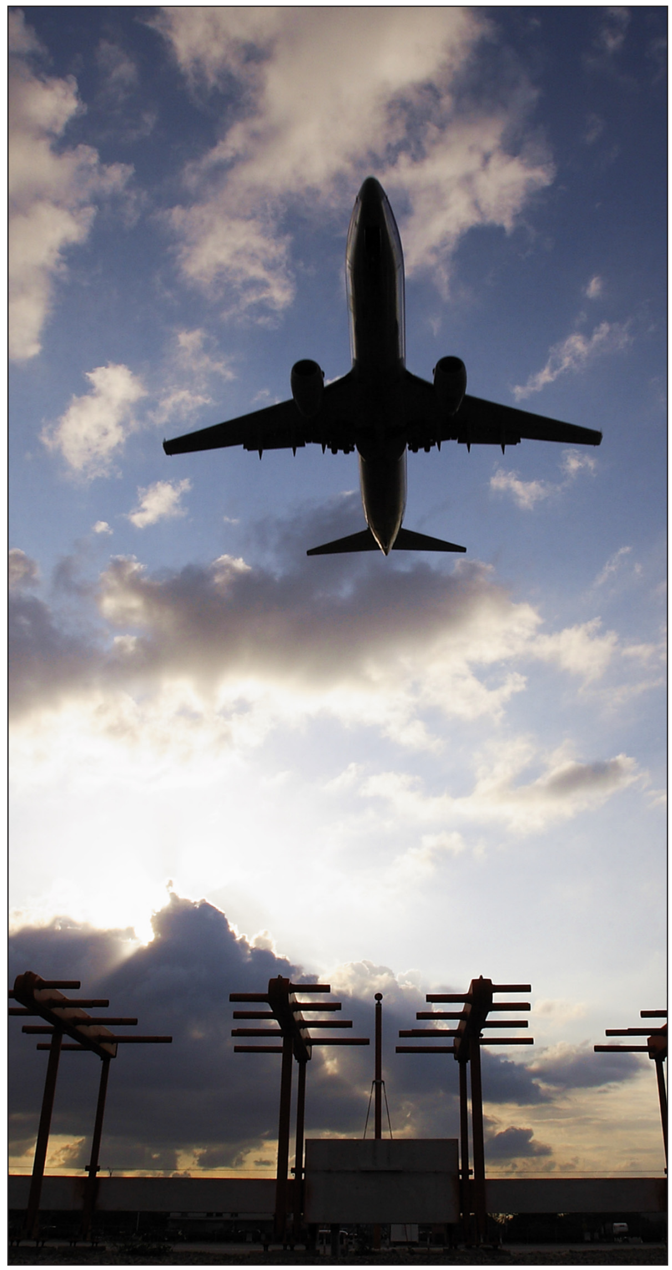
As stated earlier in the report, NextGen capabilities stress the importance of “distributed decision making… increased user focus and the provisioning of information to users.”[8] Net-centric Operations facilitate shared situational awareness through comprehensive information exchange. Given this broad statement, the current FAA NGIP does not address the data availability that will be required to bring this to fruition. SWIM is the vehicle by which all data related to the status of the NAS will be available to system users. Currently, the content of data flowing through SWIM has not been fully developed and the FOCs are not presently part of that development process. Aside from matters of national defense and highly sensitive user data, there needs to be complete transparency regarding planned operations and any impacts that are forecast in the NAS. This data must be available to those users, as well as third-party providers acting on behalf of the users of the system. In the end state, users

will have visibility into the types of data that are available via SWIM, along with related data definition information. Once access is granted to SWIM, this data will be available for unfettered consumption. The users must also recognize that data must also be provided to the system via SWIM. Planned schedule and planned trajectories will be available for determination of capacity restrictions. There are examples today of useful data exchange that occurs between the FOC and the FAA via simple teleconference for regional traffic management issues (for example, the Texas hotline used for discussion between FOCs and the FAA local facility for Off Schedule Operations [OSO]). This type of interaction needs to expand and transition to digital format for incorporation into the systems used by the FOC, and be standard operating procedures for the entire NAS.

[8] Operational Concept for the Next Generation Air Transportation System (NextGen)

Finding 5 –There is a lack of appreciation for and incorporation of the role of the FOC to ensure success of the FAA Data Communications program.

The important role of the FOC is not specifically addressed in NextGen documents. From a planning or optimization perspective, the FOC is the initial point of contact for non-safety critical communication with the aircraft. Too often, the discussion of air/ground data link communications is only about the role of the pilot and controller without the active engagement of the FOC. FOCs have up to three decades of experience with air/ground data link communications. Data link for operational control is used extensively by commercial and business aircraft operators as well as the DOD to assist with tactical and strategic decision making. This knowledge and experience will be needed to ensure the successful implementation of the FAA Data Communications program.



Recommendations

Recommendation 1 – Involve the FOCs upfront and continually in NextGen planning and implementation activities.

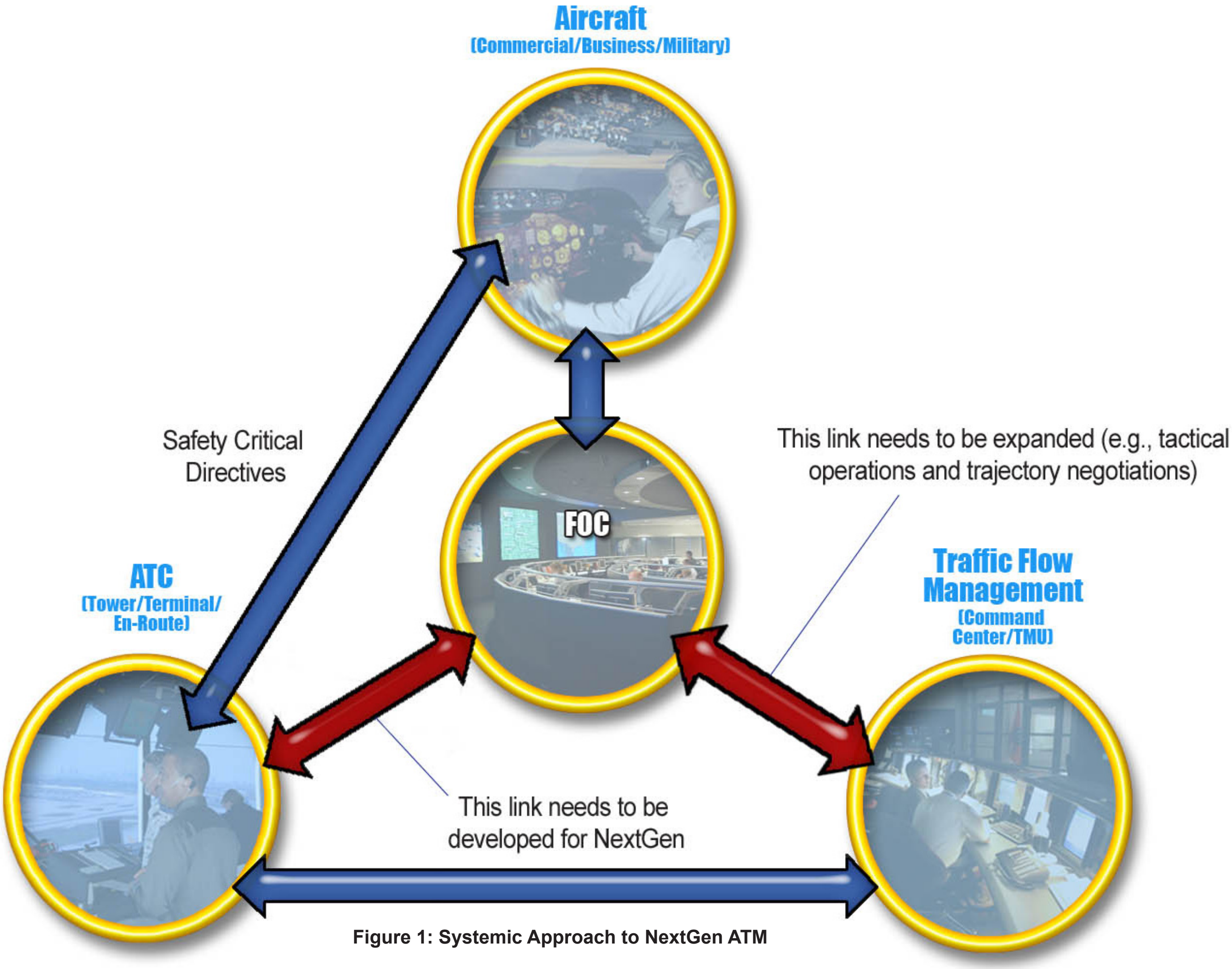


Figure 1: Systemic Approach to NextGen ATM

As shown in Figure 1, FOCs have a central role in managing the complex interactions responsible for transporting people and goods throughout the system, and need to be more actively engaged.

The FOCs need to be involved in the NextGen planning and implementation processes.

The foremost recommendation is to have direct involvement of the FOCs and their processes in the NextGen planning and implementation activities and to create and execute processes that provide for this involvement. The involvement must go beyond meetings and advice to include concept development, and verification and validation of NextGen concepts. The Study Team recognizes that the many operational trials and demonstrations underway (e.g., Greener Skies, NextGen Test Bed) have tremendous value. While these should continue, they would benefit from greater and more direct FOC involvement. A SESAR Work Package 11[9] type of effort, in which FOCs and the developers of FOC technology engage to explore how flight-planning technologies can incorporate the status of the NAS in the optimization of trajectories and continually monitor and re-optimize as changes develop, would also help. Concepts such as TBO should be revised to more accurately capture the role of FOCs in fleet and flight decision-making. Input from the FOCs should be solicited to develop overall system metrics that capture NextGen improvements to air transportation.

Incorporate FOC decision making in TBO planning documents.

TBO Scenarios should be modified to include the role that the FOC will play in the NextGen concept. This will be initiated by expanding the data shared by the FAA on the status of the NAS, thus providing for a fully collaborative constraint environment. FOC experts could provide subject matter expertise to the scenario writers. The Study Team also recommends that participants in the TBO process visit one or more FOCs to get a more direct understanding of their role and capabilities.

An enhanced formal cross-training process between dispatchers and controllers, as well as researchers and managers, should be instituted. All parties will benefit from a better understanding of the daily challenges faced in the FOC and in ATC Centers. An example of successful cross-training is the recent FAA participation in the Cockpit Access Security System (CASS) program, allowing controllers to ride in the cockpit jump seat of participating domestic operators' flights. Another example is the CDM spring training class, jointly developed by FOC and FAA personnel. The FAA and operators are encouraged to establish similar formal and informal training opportunities between FOC and ATC Center personnel.

The role of the FOC will be to optimize the gate-to-gate flight trajectories, and to optimize the entire network or schedule of flights. Surface and airspace information will need to be continuously updated and shared for the FOC to optimize the trajectory of their flights, based on their business objectives, during the entire lifecycle of the flight. As addressed earlier in the findings, a rationing scheme, complete with mechanisms that support fleet decision making should be devised to ensure equity. With a method of managing constrained resources in place and complete information on the status of the NAS, the FOC will possess the data to submit an optimized trajectory prior to departure, sequence the flights on departure and arrival, continually monitor and re-optimize the trajectory based on changes in the NAS, and efficiently manage their entire network of flights. This reliance on FOC ground-based rather than aircraft avionics distinguishes NAS transformation from ATC modernization.

[9] SESAR WP II Flight Operations Centre System – WP11 is integral part of the SESAR work program. The objective of WP11 is to define and validate the requirements for the business/mission trajectory planning, execution, update, and revision processes seen from a generic FOC system perspective. WP11 will deliver a comprehensive set of requirements, system, and interface specifications, and the means for proof of concept of future FOC systems compliant with the SESAR CONOPS. It is also necessary to address the needs of airspace users that do not operate an operations control center. Activities in WP11 include the development of technology and system prototyping solutions for input to the validation of the overall ATM system target. All consequent system development activities are directly linked to performance improvements and/or identified operational needs.

Recommendation 2 – Expand the present FAA planning horizon to improve strategic decision making.

Improved planning leads to better predictability and enhanced confidence in the system. The current FAA planning horizon needs to be expanded well in advance of the day of operations to allow strategic decision making to be effectively incorporated to optimize the system. The increased planning horizon should improve coordination and will likely require expanded data exchange with the FAA. This increased window of time will create a higher probability of NAS success as the FAA will have flight-specific information sooner before operations. This shift to strategic planning should decrease the number of tactical decisions currently being made between the air traffic controller and pilot.

Progressively expand collaborative planning horizon.

NextGen should expand the current planning time horizon and develop the processes and procedures necessary to support this expansion. Existing operator data supports the high probability and predictability of a flight occurring on schedule. The high predictability of operator plans and schedules will support expanding the collaborative planning horizon to at least 36 to 48 hours prior to operation. Improved methods to support decision making under uncertainty should also be developed and implemented. An overriding requirement for the successful implementation of the expanded horizon is the requirement for the improved weather forecasting that is anticipated under NextGen. Equally important is the need to translate weather forecasts into estimates of airport and airspace capacity.

Enhance current data-sharing mechanisms to support expanded planning horizon.

New data sharing and procedural changes may be required to support an expanded planning horizon. Data elements, such as flight intent, equipage state, runway events, and delay information, should be made available to operators and the FAA as early as possible to improve planning and predictability. Changes that might be required include expansion of the shared data content, new enabling technologies, and new collaborative processes. Examples of new collaborative processes include techniques such as incremental decision making, contingency planning, and goal setting.

Recommendation 3 – Determine and implement a clear and improved rationing mechanism for NAS resources that become scarce.

The FAA should solicit input from the FOCs, in concert with ATM and technical experts (supporting operators and the FAA), to develop a clear rationing mechanism that improves upon today's resource-specific rationing mechanisms (ration by schedule, Traffic Management Adviser). The rationing mechanism should also address the processes operators can use to establish different priorities between flights, or to trade resources with other operators. The Study Team recommends that a concept development project be initiated—with the involvement of FOCs—to explore, refine, and develop improved rationing mechanisms. A direct path to achieving this would involve leveraging the substantial amount of research conducted on the development of system-level and network approaches to constraint management. The objective is to produce more predictable system-level approaches that move beyond the Flight Schedule Monitor (FSM), which today manages one airport (i.e., GDP) or airspace constraint (i.e., Airspace Flow Program [AFP]) at a time.

Ensure rationing mechanisms provide proper incentives for demand reduction.

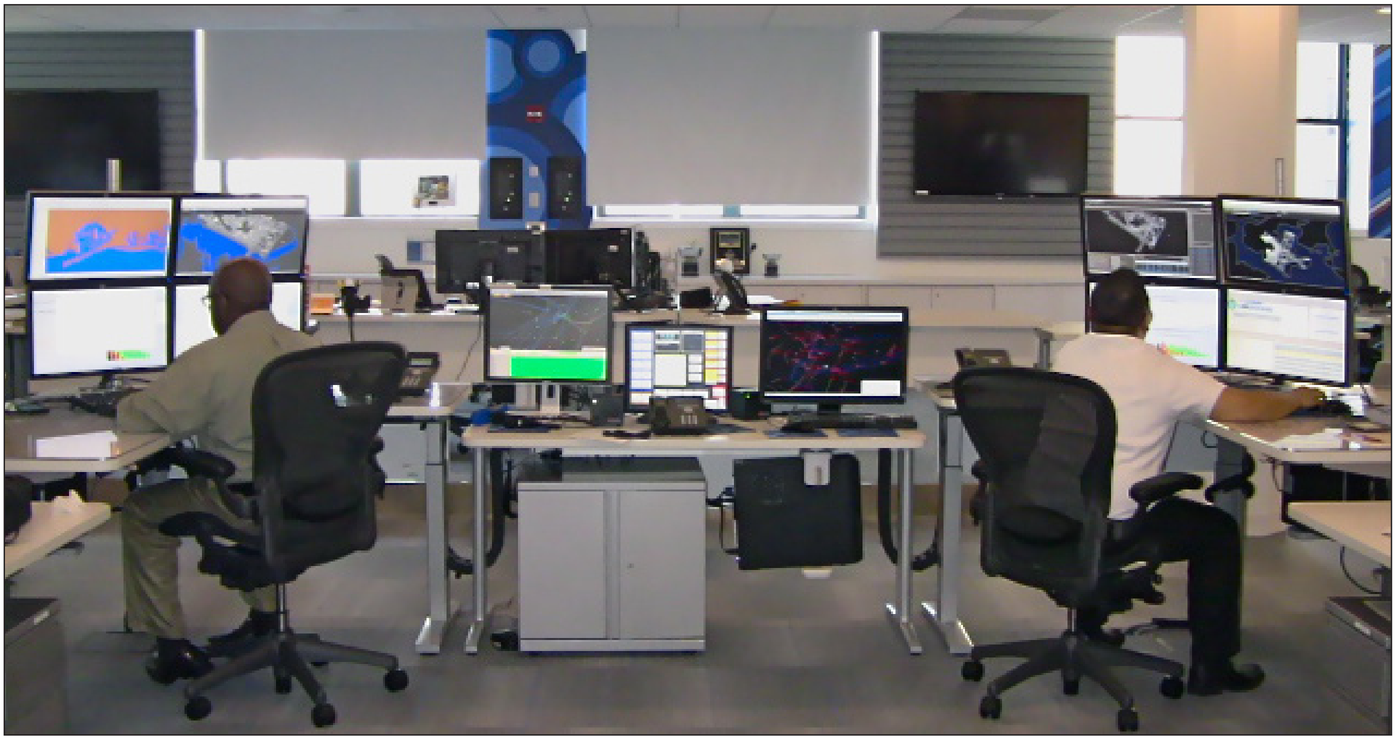
Today, when system capacity is constrained, operators have an incentive to reduce arrival demand through cancellations. This incentive is attained by the notion of arrival slot ownership; the operator owns an assigned arrival slot, not the flight. An analogous construct should be established to provide similar incentives under NextGen. For example, an incentive could be developed to credit outbound flights when arrival demand is reduced by inbound cancellations. Rationing mechanisms should be developed to specifically address integration with related policy and procedural changes, such as the tarmac rule.

Solicit FOC input on rationing mechanisms to ensure equitable allocation of scarce resources (e.g., airport and airspace capacity).

Although equity has never been fully defined in today's NAS, it remains an important issue. Equity is usually addressed by avoiding egregious inequities. NextGen should more clearly institutionalize the notion of equity by developing robust, transparent rationing mechanisms. The Study Team recommends that clear equity guidelines and associated performance metrics be developed with input from FOCs.

Investigate fleet optimization enabling mechanisms for NextGen.

The arrival slot has evolved into a powerful mechanism through which operators can override flight delay assignments (via substitutions, compressions, slot credit substitutions, etc.) and produce a better fleet or system outcome. But today's arrival slot is airport- or Flight Constrained Area (FCA)-specific. Under NextGen, the Study Team envisions a much more expansive mechanism that can function when multiple constraints are in effect simultaneously. The intent is to enable operators to optimize networks of flights subject to networks of constraints (versus individual flight optimization for individual/localized constraints). The Study Team recommends that existing research be leveraged, with direct FOC involvement, to investigate the enabling mechanism for making fleet decisions when subjected to multiple NAS constraints.



Recommendation 4 – Expand and formalize data sharing.

Data sharing is incredibly important today and will be vital to the success of NextGen going forward. The recommendation is to expand and create uniform rules for data sharing, defining the roles and responsibilities of each party, the timing, governance, protection of proprietary data, FOC access to SWIM, and the content of SWIM. Lessons learned from CDM data sharing should be leveraged to improve common, current, and predicted situational awareness, which is essential to support the evolving centralized control/decentralized operations model to which U.S. and international operators are moving. (For additional information, please see Appendix B.)

While there is a lot of activity concerning data sharing, the Study Team feels there are specific areas that need more focused attention.

Formalize data-sharing rules, roles, responsibilities, quality, timing, and governance.

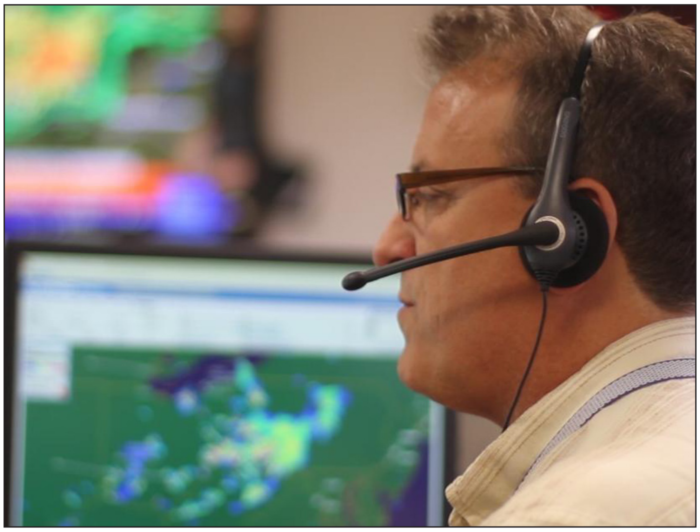
- Build upon the data sharing accomplished through CDM as a way forward. The rules for data sharing are not uniform throughout the system. Rules should encompass how both direct and indirect NAS stakeholders participate in data sharing, including operators and the Information Technology (IT) development organizations that support them. Rules and abilities for all data sources should include all phases of the software lifecycle, including research, development, and testing for all participants in a consistent, manageable fashion. The level of difficulty in doing this should not be underestimated.
- As important as the rules of data sharing are, the roles of those involved with data sharing are also critical. Today, the roles of data sharing are not widely understood or their effectiveness appreciated. For example, the FOC and Pilot-in-Command (PIC) share a lot of data: weather updates (including turbulence plots and time-sensitive convective weather information), route planning updates, changes and corrections, etc. A better understanding of data-sharing roles today will enable better data sharing going forward.
- All participants in the NAS have a responsibility for data sharing. The party that creates the data and has early knowledge of any changes should be responsible for sharing this data and updating it in a timely manner. Data originators should also be accountable for data quality. For example, poor data quality has been persistent over the past 15 years of CDM. Yet concrete steps have not been taken to improve data quality, which starts with identifying the responsible parties.
- Most data should be shared immediately. There are some examples where data cannot be shared immediately. For example, when an airline is going to cancel a flight, but before the slot cancellation information is shared, that airline tries to find one of its partner airlines to cover that flight and use that slot. This does not happen very often but still must be considered. Whether decisions are synchronous or asynchronous, greater emphasis on the timing of data sharing to support decision making is required.
- Effective governance will lead to greater clarity of rules, access, protection of proprietary data, and the like. There are various forums trying to address these issues (e.g., JPDO Enterprise Information Sharing Study Team [EISST] and the FAA Data Sharing Council). These efforts should continue and ensure that they are providing a unified set of rules while incorporating the FOC perspective. For the operators, an effective governance model requires a single point of contact in the FAA for access to operational data.

Formalize protection of proprietary data.

While the openness of data sharing is very important, there is some proprietary information that is sensitive and must be protected. CDM wrestled with this subject for years with the Aggregate Demand List (ADL) that contains airline-provided dynamic schedule changes. NextGen should leverage the lessons learned from CDM and craft a set of policies and rules that ensure protection of operator-provided proprietary data, without impairing its distribution to appropriate parties or violating any antitrust rules and regulations.

Formalize FOC access to SWIM.

Operators are very interested in sharing data through SWIM and want to ensure that SWIM evolves in a way that meets both FAA and operator needs. This would require a clear and well-defined process for SWIM access, and the operators must have the flexibility to designate a third party



(e.g., outsourced IT department) as a SWIM connection point. This should be pursued in SWIM development, so operators can refine their technical interfaces and develop methods for integrating selected data into their automation tools. Further, FOC input should be solicited on data content (what data is being distributed via SWIM).

Standardize all data-sharing activities.

In the near-term, it is important the FOCs provide input for development of data-sharing policy, currently being worked by FAA's Office of System Operations, Data Management. Work on data sharing is also being done through various workgroups, the JPDO, and the NextGen Institute. A single office should have responsibility for standardizing the rules, roles, responsibilities, and processes across all data-sharing activities.

Key to a standard data-sharing process would be well-defined metadata—the description and definition of the data elements being shared. This is vital to ensure that there is a clear, common understanding of what is meant by specific data elements. For example, the FAA often requests intent information. Many operators would suggest that intent information is already contained in their published schedule; however, there are those in the FAA to whom intent means a precise trajectory, and this leads to misunderstanding. Until we have a common understanding of what is meant by intent, there will be an impasse. With far greater data sharing anticipated under NextGen, it is vitally important that definitions and meanings be standardized.

Recommendation 5 – Expand data communications.

This recommendation is about expanding data communications beyond pilot/controller interaction by leveraging the experience, capabilities, and infrastructure of FOCs.

The FAA Data Comm Program Office, in association with the Data Comm Integrated Services (DCIS) prime contractor, should formally reach out to the FOC community to create a FOC/ATC data link communications Working Group.

Since the late 1970s, FOCs have been using data link to communicate with aircraft, both on the ground and in flight, for purposes of operational control. The original messages communicated via data link, transmitted Out, Off, On, In (OOOI) times, provided the FOCs with an automated means of determining flight status. Data link messages have continued to evolve and today provide the critical communications link between aircrews and dispatchers.

Data link messages are delivered over private networks using VHF, HF, or satellites. The current system is mostly used by the dispatch function, which varies depending on the type of operation: commercial air carriers through the AOC, business jet operators through the FOC, and military through the WOC. Today, over 8,000 aircraft from domestic Part 121 carriers and 5,000 business aircraft use data link communications using the Aircraft Communications Addressing and Reporting System (ACARS) message format.[10] Over one million messages a day are delivered to aircraft using the ACARS data link.

[10]DataComm Roadmap, A Report of the NextGen Advisory Committee in Response to Tasking from the Federal Aviation Administration, February 2012.

One of the cornerstones of the DCIS program is the use of the existing data line infrastructure. The FAA should incorporate data link lessons learned by the FOC as they roll out the DCIS program. This Working Group would provide input on the DCIS program roadmap and provide continuous feedback to the FAA Data Comm Program Office. In the near-term, this action will help ensure the seamless addition of Air Traffic Services (ATS) data link communications messages to the information flow between ATS and the FOC. In the long-term, the use of data communications can contribute to enabling NAS transformation through potential actions, such as using existing ACARS for initial implementation of TBO.

The FOCs should develop processes and procedures to handle data link messages between controllers and the flight deck.

The FAA's DCIS program will bring ATS data link communications messages between the flight deck and the air traffic controller into the NAS. Along with impacts to the flight deck and the air traffic controller, ATS data link messages will also have impacts on the FOC. As a result, ATS data link messages should be added to the information flow between FAA and the FOC. While airlines have been involved with providing input to the DCIS program, most of the airline involvement has been from the pilot community with little direct input from the FOC community. As noted previously in this report, engaging the FOCs is an important first step. In addition, operators should develop internal plans for using the ATS messages from the FAA, and work with the FAA to determine the proper process for the two groups to interact. The role of the FOC needs to evolve into an active and engaged partner in ATM. As more information becomes available, the FOC needs to play a larger role in the active management of the NAS throughout the lifecycle of a flight.

Recommendation 6 – Conduct collaborative experiments with FOCs.

There are many NextGen trials, demonstrations, and experiments underway that focus on one or more aspects of NextGen technology. For example, the JetBlue Other Transaction Agreement (OTA) involves the use of ADS-B Out to egress the New York area offshore. The Daytona Beach NextGen Test Bed provides a strong platform where integration and testing of NextGen capabilities takes place without affecting day-to-day operations. The Seattle Greener Skies initiative is improving upon RNAV procedures and implements the RNP component and Optimized Decent Profiles (OPD). A virtual queue experiment is being pursued by the FAA Surface Office and is intended to avoid high-cost fuel burn queuing on the airport surface through the creation of a virtual queue. These and other important NextGen experiments should continue, but should be expanded to ensure the FOC perspective is included. Attention also needs to be given to the construction and conduct of additional NextGen experiments with a specific FOC focus.

The following projects/demonstrations should be considered as a starting point.

Refine and improve current data-sharing processes and data.

NextGen should explore whether technical improvements can be made to the current data exchange process to improve accuracy and effectiveness. Sharing information and data between airport operators, aircraft operators, ground handlers, and air traffic control will improve service and reduce costs for all users and providers. Sharing real-time information, from long-range planning of schedules to the tactical decisions of ground-delay programs, will help maximize system operations and user benefits.[11] Questions that should be explored include:

- Is there a need for tighter data quality thresholds to improve the quality of operator-provided data?
- What additional data is necessary to support effective planning of 4D trajectories at levels of assurance to gain approvals for clearances (thus delivering tangible NextGen benefits)?
- How can the delivery format of the data be redefined to move away from the existing Teletype message format?
- Are incentives required for operators to share data and what are those incentives? Are they similar to the GDP compression process, which was an incentive for operators to invest in data sharing?

[11] Collaborative Decision Making, AirServices Australia

Develop enabling capabilities for expanded time horizon.

The FAA, in concert with operators, should explore whether new tools/programs/concepts/rationing mechanisms are needed to support an expanded planning horizon. Tools and processes that may be applicable on the day of operations could be decidedly different a few days before, or even during the scheduling process (when NAS uncertainties are high). Concept exploration projects (leveraging existing working groups, such as the CDM Flow Evaluation Sub-Team) should be constructed to assess various planning time horizons with the objective of expanding the current horizon to 36-48 hours initially, and eventually to several months. The longer time horizon enables more cost-effective resolutions of potential congestion and related issues, and also involves tradeoffs, as uncertainty will be higher in these earlier time horizons. While the operators generally see great value in expanded planning time horizons, this has not been incorporated into operational procedures. A properly conducted collaborative experiment could help both sides understand the value of an expanded time horizon. For example, trials could be conducted using historical data to assess the value of an earlier planning horizon. Experiments/demonstrations should focus on how to allocate scarce capacity in an expanded time horizon when NAS uncertainty is high. This would require the application of probability theory and related fields.

Rationing mechanism

- Experiments should be formed to explore new rationing mechanisms, such as network-based approaches to managing capacity/demand imbalances, or stochastic approaches, new trading processes, etc. Focus should be placed on a unifying TMI approach that ensures that conflicts are resolved when flights are impacted by multiple TMIs. Critical questions in this concept exploration experiment include: Are there constraints for which a dynamic flight list is not being generated and updated? Are there NAS constraints that are not being distributed to operators in a timely fashion?

Collaborative System Metrics

The FOCs, in collaboration with the FAA, should help develop cost drivers and track total system operating costs. Experiments could be conducted whereby a new set of metrics that provide insight on system outcomes and strategic decision making are generated. These collaborative metrics should capture system performance measures for the operation of the air transportation system (e.g., changes in operating costs, passenger delay, missed connections, the effects of cancellations, fuel burn) and complement existing NextGen performance metrics. While many system-oriented metrics have been

proposed through various forums (e.g., CDM, the RTCA Metrics Working Group), the Study Team recommends that experiments be conducted that put such metrics to test and expand them to include corporate, finance, and other issues that can provide insights into the performance of the air transportation system.

Collaborative metrics experiments can have both near-term and mid-/long-term goals. For example, one set of experiments could concentrate on the ICAO Aviation System Block Upgrades (ASBUs). Others could focus on the operational changes associated with Best Equipped Best Served (BEBS). Still another set could focus on the longer end state of NextGen.

FOC Trajectory Negotiation in the TBO Environment

NextGen tools are expected to enable collaborative negotiation of 4DTs. To ensure FOC involvement in trajectory management throughout the lifecycle of a flight, research should be conducted to evaluate the nature and time sensitivity of the interactions between the parties to trajectory negotiation (i.e., ATC, TFM, Air Traffic Control System Command Center [ATCSCC], FOC, and pilot), and define roles and responsibilities of the parties. This research should also explore electronic negotiation tools and procedures for planning, initiating, coordinating, issuing, and accepting or rejecting trajectory changes. This experiment should leverage existing research projects, such as the FAA's ANG Office's examination of Dynamic Network Analysis (DNA) as an ATM modeling technique. This will provide a scientific means of contrasting the value of traffic manager-FOC interaction versus an exclusive pilot/controller-centric approach to ATM.

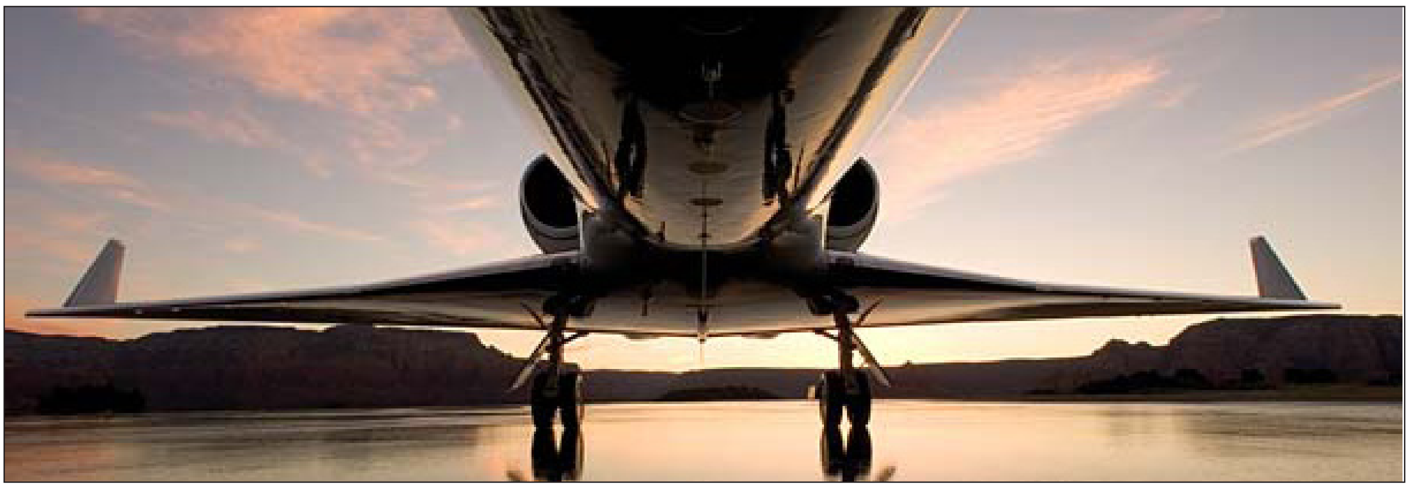
Appendices

Appendix A		
Workshop Participants		
Workshop 1: Role of FOCs in the Evolution of NextGen		
Industry Participants		
Last Name	**First Name**	**Company**
Alexander	Frank	IATA
Ball	Michael	NEXTOR
Ford	James	Delta
Fujisaki	Norm	Metron Aviation
Gazlay	James	Pinnacle
Gulstrom	Steve	FedEx
Hopkins	Mark	Delta
Howland	Ray	American Airlines
Kern	Samuel	UPS
Martin	John	JetBlue
Okeeffe	Giles	Metron Aviation
Osborne	Jeff	American Airlines
Smith	Phil	Ohio State University
Stellings	Ernie	NBAA
Weber	Mark	Lincoln Labs
Government Participants		
Last Name	**First Name**	**Agency**
Bedow	James	FAA
Darr	Steve	NASA Contractor
Grimm	Kevin	FAA
Gustin	Josh	FAA
Hatton	Kevin	FAA
Huberdeau	Mark	MITRE
Lee	Arnold	JPDO Contractor
Marina	Craig	FAA
McCarron	John	FAA
McMahon	Steve	FAA
Pace	David	FAA
Somersall	Pat	FAA
Usmani	Ahmad	FAA
Zettlemoyer	Mark	JPDO
Facilitators/Presenters		
Last Name	**First Name**	**Company/Agency**
Elson	Don	USAF/AMC
Gambarani	Gary	ARINC
Harrison	Michael	Aviation Management Associates

Merkle	Michele	FAA
Morris	Cynthia	FAA
Van Trees	Steve	FAA
AOC/FOC/WOC Core Team		
Last Name	**First Name**	**Company/Agency**
Babcock	Lawrence	Lufthansa Systems
Bertapelle	Joe	JetBlue
Collier	Amy	JPDO Contractor
Emanuel	David	JPDO Contractor
Garvin	Michael	NextGen Institute
Hawkins	Ron	ARINC
Keegan	Maureen	JPDO
Kemmerly	Guy	NASA
Knight	**Dana**	**Sabre, Co-Lead**
Leber	Bill	Lockheed Martin
Sud	**Ved**	**FAA, Co-Lead**
Wambsganns	Michael	Crown Consulting
Witucki	John	USAF
Workshop 2: Data Exchange and Sharing		
Industry Participants		
Last Name	**First Name**	**Company**
Ball	Michael	NEXTOR
Fujisaki	Norm	Metron Aviation
Fuller	David	JetBlue
Gambarani	Gary	ARINC
Goehler	Dave	Jeppesen
Harrison	Michael	Aviation Management Associates
Howland	Ray	American Airlines
Kern	Samuel	UPS
Okeeffe	Giles	Metron Aviation
Oley	Frank	Airlines for America
Osborne	Jeff	American Airlines
Qualley	Warren	Harris
Stellings	Ernie	NBAA
Weber	Mark	Lincoln Labs
Government Participants		
Last Name	**First Name**	**Agency**
Burgess	Shirley	FAA
Cass	Lorne	FAA (AJR-11,SURFSPO)
Elson	Don	USAF/AMC
Hatton	Kevin	FAA (ANG)
Meyer	Thomas	FAA Contractor
Miller	Col. Patrick	USAF

Mowery	Marshall	FAA (AJR-11,SURFSPO)
Oiesen	Rick	VOLPE
Pace	David	FAA (ANG)
Zettlemoyer	Mark	JPDO
Facilitators/Presenters		
Last Name	**First Name**	**Company/Agency**
Colliver	Forest	MITRE
Gustin	Josh	FAA (AJR-44)
Hayes	Jim	CSC
LaClair	Ken	JPDO/USAF
Novak	Mark	FAA
Somersall	Patrick	FAA (AJR-113)
Tanino	Midori	FAA (AJR-52)
Usmani	Ahmad	FAA (AJW)
AOC/FOC/WOC Core Team		
Last Name	**First Name**	**Company/Agency**
Bertapelle	Joe	JetBlue
Collier	Amy	JPDO Contractor
Garvin	Michael	NextGen Institute
Hawkins	Ron	ARINC
Keegan	Maureen	JPDO
Kemmerly	Guy	NASA
Knight	**Dana**	**Sabre, Co-Lead**
Leber	Bill	Lockheed Martin
Phifer	Douglas	JPDO Contractor
Sud	**Ved**	**FAA, Co-Lead**
Wambsganns	Michael	Crown Consulting
Webster	George	Lufthansa Systems
Witucki	John	USAF
Workshop 3: Role of the FOC in the Transition from an Air Traffic Control Model to an Air Traffic Management Model		
Industry Participants		
Last Name	**First Name**	**Company**
Fujisaki	Norm	Metron Aviation
Hopkins	Mark	Delta
Howland	Ray	American Airlines
Kern	Samuel	UPS
Martin	John	JetBlue
Okeeffe	Giles	Metron Aviation
Oneil	Thomas	American Airlines
Qualley	Warren	Harris
Smith	Phil	Ohio State University
Stellings	Ernie	NBAA
Stojkovic	Goran	Jeppesen

Government Participants		
Last Name	**First Name**	**Agency**
Hatton	Kevin	FAA (ANG)
Huberdeau	Mark	MITRE
AOC/FOC/WOC Core Team		
Last Name	**First Name**	**Company/Agency**
Bertapelle	Joe	JetBlue
Collier	Amy	JPDO Contractor
Garvin	Michael	NextGen Institute
Hawkins	Ron	ARINC
Knight	**Dana**	**Sabre, Co-Lead**
Sud	**Ved**	**FAA, Co-Lead**
Swenor	Patricia	JPDO Contractor
Wambsganns	Michael	Crown Consulting
Witucki	John	USAF



Appendix B

A Framework for Capitalizing on Data Exchange

Enabling better decision making and operational benefits for all stakeholders.

The AOC/FOC/WOC of the Future Study Team notes that data exchange is a tenet to achieving NextGen goals and a key enabler for CDM. But data exchange alone will not result in operational benefits. A framework is required to enable data to be transformed into quality information and provide shared knowledge, which can then transform the operational decision-making process. To realize the full potential of enhanced data exchange capabilities it is paramount to connect the operations to capabilities to systems across the entire stakeholder community. New ways of doing business will be enabled through access to more timely, accurate, and consistent information.

A layered framework is required to ensure success in transforming data into operational change. The first layer, or foundation, is the data itself. Elements in this level are in the form of data gathering, storage, and retrieval; its ownership, agreements for use, and performance characteristics (latency, quality, persistence) also fall in this category. Examples of ATM data needs include flight data, navigation data, surveillance data, data on the nature of flights affected by TMIs, and weather data.

The next layer in the process includes enablers for information exchange. This layer provides the exchange standards and mechanisms for transitioning data into shared information. Capabilities such as SWIM and flight, weather, or Aeronautics data-exchange models are examples of what is required in this layer of the framework. The interoperability of the information exchange will allow for the access of information and knowledge between the decision-making actors. The first two layers require an architecture, which will allow the ability to build the downstream decision-support tool components of the framework.

A third layer in the framework is the application of information into the decision-making automation support systems and system integration. Applications in this layer overlay decision support logic on top of the shared information made available from the previous two layers. Systems such as flight planning automation systems (FOC), Traffic Flow Management System (TFMS) (FOC and ANSP), EnRoute Automation Modernization (ERAM) (ANSP), or other decision-support tools (DST) are all consumers of data, and provide some capability to operators. Access to shared information across these platforms may provide individual benefits in the form of common situational awareness and interoperability; however, it is envisioned that NAS performance and system gains will be much greater when these network-centric capabilities can be applied to making transformational changes to operational processes, procedures, business rules, and collaborative decision-making actions. In providing the first three layers of the framework, we will expect to incur some cost in the building and development of the capabilities required.

Once the base infrastructure is in place, benefits can begin to be realized in the fourth layer where operators can begin to use the information exchange in interlocking decision-making processes and business practices. This fourth layer involves supporting the people involved in evaluating the situation and making decisions. As noted in the discussion of the third layer, this is achieved in part through the introduction of decision-making automation support systems that help transform the data into actionable decisions. In addition, however, this information, including the output of such decision-support systems, needs to be displayed to operational staff in a form that supports individual, coordinated/synchronized, and collaborative decision making as appropriate.

From a human factors perspective, to support individual and coordinated or synchronized work, the data and information needs to be filtered and represented in a manner that displays it to each individual in a manner that supports the particular tasks allocated to that person. For such individual work, each person needs to see different subsets of the overall data, displayed appropriately. This

may include displays that indicate the plans developed and actions taken by other individuals in this distributed system so that proper coordination or synchronization is maintained, but is does not mean that everyone should see the same information represented in the same way. In short, to support individual and coordinated/synchronized tasks in a distributed system where the work has been decomposed into nearly independent subtasks, shared situational awareness means that the information displays viewed by different individuals are based on the same underlying data and model of the world. It does not mean that everyone should see all of the same data displayed in the same way.

However, collaborative work must be supported when active interactions need to occur in which the individuals involved have to actually talk with each other (either synchronously or asynchronously). Such collaboration needs to occur when the independent but synchronized work is not adequate because these individuals need to bring their different perspectives together, conversing to evaluate the situation and determine what actions should be taken. In this case, shared situational awareness may in fact require that all of the people involved have access to the same information displays.

Current examples of that include individual, coordinated, and collaborative work processes, including Ground Delay Programs (GDP), Airspace Flow Programs (AFP), and Collaborative Airspace Constraint Resolution (CACR). NextGen Collaborative Air Traffic Management (CATM) processes can be built upon this framework if the access and building blocks are inclusive of all stakeholders as these technologies are developed and deployed over the lifecycle of NextGen.

Appendix C

Acronyms

4D	Four-Dimensional
4DT	Four-Dimensional Trajectory
AAS	Advanced Automation System
ACARS	Aircraft Communications Addressing and Reporting System
ADL	Aggregate Demand List
ADS-B	Automatic Dependent Surveillance Broadcast
AFP	Airspace Flow Program
ANSP	Air Navigation Service Provider
AOC	Airline Operations Centers
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
ATS	Air Traffic Services
CASS	Cockpit Access Security System
CDM	Collaborative Decision Making
DCIS	Data Communications Integrated Services
DO	Scheduled Departure Time
DOD	Department of Defense
DNA	Dynamic Network Analysis
EOBT	Estimated Off-Block Time
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FCA	Flight Constrained Area
FOC	Flight Operations Centers
GDP	Ground Delay Program
HF	High Frequency
ICAO	International Civil Aviation Organization
IT	Information Technology
IWP	Integrated Work Plan
JPDO	Joint Planning and Development Office
JPE	Joint Planning Environment
MIT	Mile-in-Trail
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NBAA	National Business Aviation Association
NextGen	Next Generation Air Transportation System
NGIP	NextGen Implementation Plan
OI	Operational Improvement

OOOI	Out, Off, On, In
OPD	Optimized Profile Descent
OTA	Other Transaction Agreement
PBN	Performance-Based Navigation
PIC	Pilot in Command
RNAV	Area Navigation
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics
SME	Subject Matter Expert
SMS	Safety Management System
SUA	Special Use Airspace
SWIM	System Wide Information Management
TBO	Trajectory-based Operations
TMA	Traffic Management Advisor
TMI	Traffic Management Initiative
UAS	Unmanned Aircraft System
VHF	Very High Frequency
WOC	Wing Operations Centers